Assignment 5 - Arrays

Figure 1: Limestone River Texture Water Flow. Shutterstock

Objective:

In this assignment, you will use arrays and previous course topics to create a program to compare physical properties of different limestones. You will determine which has the lowest specific gravity and calculate all the flow velocities for each limestone. Then, you will determine if the limestone with the greatest flow velocity also has the highest porosity. This assignment will aid you in understanding Darcy's Law in APSC 151.

Background:

Groundwater is an essential resource to all people. It provides water to essential processes such as irrigation, livestock, and domestic use, especially in rural communities. It is stored underground in spaces and cracks in the earth it inhabits. Groundwater moves through such materials such as limestone by travelling through void spaces, or tiny holes, in the material. The porosity of the material is measured by the number of void spaces in the material. Permeability is the connection of the void spaces to allow water to flow through the material. Water can flow due to changes in elevation and pressure, which, combined, make up the hydraulic head. The hydraulic gradient is the change in hydraulic head over a change in distance (essentially, it is the slope of the water flow)

Darcy's law is used to determine the flow rate of a fluid through a porous medium. It relates hydraulic conductivity, K, which is dependent on the permeability of the material and the viscosity of the fluid, and the hydraulic gradient, $\Delta h/\Delta l$. The flow rate, Q, can be found using the equation below. Note that this equation has been simplified for the purpose of this course and APSC 151.

$$Q = -kA\frac{\Delta h}{\Delta l}$$

For this assignment, **assume a gradient of -0.725 (m/m) and a cross-sectional area of 1200 m^2 for all cases.**

In APSC151's Week 5 content, this topic is covered in further detail.

Instructions:

Below is a guideline for how to approach this problem, though you may choose to approach it however you wish. **Make sure to express your results using the format specified below**:

- Ask the user how many sets of limestone data are to be inputted by the user.
- Use this data to create an array of the needed size to store the porosity, hydraulic conductivity, and specific gravity of the limestones. Ask for and collect user input and store the data in the array.
- Determine which limestone has the **lowest specific gravity**, and print the result.
- Copy the array of data into a new array with one more column.
  - Hint: Use a nested for loop.
- Use the equation above to calculate the flow velocities of each type of limestone and print the result.
  - Express each flow velocity as a positive value for Gradescope to give full credit.
- Determine if the limestone with the highest flow velocity also has the highest porosity.
  - If yes: print "The rock with the highest porosity has the highest flow velocity."
  - If no: print "The rock with the highest porosity does not have the highest flow velocity."

Comments are mandatory for this assignment. Add comments as necessary for key pieces in your code, such as variable declaration, conditional statements, and looping conditions to explain what the program is doing.

Your output must match the sample output below exactly; otherwise, the auto grading software will not be able to grade your assignment, which may affect your mark.

Example Output:

(Note: You **DO NOT** need to print the values in bold; they are shown only to display the **scanf** input for this example.)

(Note: Make sure that the last line also prints a new line for Gradescope to give full credit.)

```
Enter the number of limestones to compare: 3

Enter the porosity %, hydraulic conductivity (m/s), and specific gravity for
Limestone 1:

0.21 0.000000051 0.0029

Enter the porosity %, hydraulic conductivity (m/s), and specific gravity for
Limestone 2:

0.25 0.00000027 0.0031

Enter the porosity %, hydraulic conductivity (m/s), and specific gravity for
Limestone 3:
```

```
0.18 0.00000009 0.0026
```

```
The limestone with the lowest specific gravity is Limestone 3 with a
specific gravity of 0.0026
```

```
Flow velocities:
```

```
Limestone 1: 44.37 cm^3/s
```

```
Limestone 2: 234.90 cm^3/s
```

```
Limestone 3: 78.30 cm^3/s
```

```
The rock with the highest porosity has the highest flow velocity.
```

Submission Instructions:

Create your program using CLion and upload it to Gradescope for grading. **Your program file must be named** "**apsc143assign5.c**" in order for your assignment to be graded. Do not include any personal information (student number, name, etc.) in your submission. If you have consulted any resources to complete your work, indicate those resources in your comments. Also, include in your comments that you attest to the originality of your work.

Refer to the assignment rubric on OnQ for a detailed breakdown of the grading criteria. Your submission must adhere to the assignment rules as outlined in the submission policy document for this course, which can also be found on OnQ. There is zero tolerance for plagiarism in this course. This auto grading software will automatically flag potential cases of plagiarism, which will be reviewed by the instructors.

More information on assignment submissions can be Found in Week 2, and information on the specific definition and repercussions of plagiarism can be found in the "Begin Here (About This Course)" module.